#459

DISEASE STUDIES AID KEMP'S RIDLEY SEA TURTLE HEADSTART RESEARCH

Since 1977, the Southeast Fisheries Center's Galveston Laboratory, (NOAA National Marine Fisheries Service) has been conducting sea turtle headstart research. Kemp's (Atlantic) ridley sea turtles *(Lepidochelys kempi)*, designated an endangered species by the U.S. Endangered Species Act of 1973, are raised in captivity during their first year of life and then are tagged and released at sea in hopes that they will continue their growth to adulthood. Analysis of the results of this project will assist to determine if headstarting can augment the natural nesting populations of the Kemp's ridley (Klima and McVey 1982).

In nature, Kemp's ridley hatchlings are highly vulnerable to mortality, primarily through predation. Turtle biologists have estimated that less than 5 percent of these hatchlings survive through their first year. With headstart techniques, about 68 to 95 percent survival has been achieved with captive turtles during this critical first year.

Kemp's ridley hatchlings are supplied to the Galveston Laboratory through the cooperative efforts of the Instituto Nacional de Pesca, Mexico, the U.S. Fish and Wildlife Service, and the U.S. National Park Service. They are reared for 7 to 12 months and those in good condition are tagged and released off Padre Island, Texas (earlier release sites included the west coast of Florida) (J. P. McVey and R. S. Wheeler, pers. comm. 1978-1981). Also, approximately 86 headstarted yearlings of the 1978 and 1979 year-classes have been distributed to Miami Seaquarium in Miami, Florida, and Sea Arama Marine World in Galveston, Texas, to provide a potential captive brood stock (R. S. Wheeler, pers. comm. 1981). Of these turtles, 8 are still surviving at Miami, and 10 at Galveston (F. H. Berry and R. M. Harris, pers. comm. 1983).

At the beginning, loggerhead *(Caretta caretta)* hatchlings rather than Kemp's ridley hatchlings were reared so that the Galveston staff could gain experience for future application to the endangered ridleys. In September 1977, 1,160 loggerhead hatchlings, obtained soon after hatching from eggs collected by the Florida State Department of Natural Resources, Jensen Beach, Florida, were shipped to the Galveston Laboratory. These hatchlings were reared communally in large close-ended concrete tanks (raceways), containing recycled natural seawater, and originally designed for shrimp culture (C. R. Mock and C. T. Fontaine, pers. comm. 1977). Later, many culture methods were developed and used, including flow-through tanks in which the seawater was constantly and gradually exchanged through a supply valve and a drainage outlet (A. Brown, Jr. and R. S. Wheeler, pers. comm. 1977). The animals were fed mainly a frozen fish diet.

The decision to experiment first with the loggerheads proved to be quite beneficial. Although there was only a 9 percent loggerhead survival, by the end of the 10-month rearing period the staff had learned much about turtle diseases and their prevention and treatment. Almost 100 percent of the loggerhead hatchlings became ill at one time or another and many died. The most serious kind of death (about 40 percent) involved a "sudden hatchling death" (SHD) syndrome in which the animals suddenly died without any discernible cause. Other commonly occurring diseases were skin and shell lesions, eyelid infection, emaciation, bowel obstruction, and anal infection (Leong 1979). Mortality due to SHD rapidly dropped from a peak of about 4 percent to about 0.2 to 0.3 percent per day when the turtles were transferred from the closed raceways to flow-through tanks. However, the other diseases appeared one after another.

Laboratory work indicated that the primary requirements for disease treatment and control were clean water and individual isolation of sick turtles. Both requirements were met by holding individual sick animals in plastic 10-liter buckets containing seawater, which was changed daily. When necessary, therapeutic drugs or antibiotics were administered topically, by intraesophageal intubation or by subcutaneous injection. The development of isolation techniques and chemotherapy led to the recovery of many sick turtles. A successful therapeutic treatment involved the use of static formalin bath in conjunction with injections of an antibiotic such as ampicillin or chloramphenicol.

During July and August 1978, the first shipment of 3,081 Kemp's ridley hatchlings was received at the Galveston Laboratory. The turtles were reared together in large, communal, fiberglass raceways. Water was changed completely three times weekly. The turtles were fed a commercial pelletized feed.

Every turtle contracted diseases or infections of one kind or another. Some illnesses were similar to those we had experienced with the loggerheads, but there were also many new diseases. In addition, the ridley hatchlings were extremely aggressive, and soon after being placed in the raceways most suffered injuries caused by either biting or scratching each other. Such aggressive behavior was not observed in the loggerheads.

Most of the diseases and injuries in the 1978 year-class of ridleys were successfully controlled through isolation and treatment techniques as previously established for loggerheads. However, the maladies recurred after the ridleys were returned to the communal raceways. Experiments showed that biting and wounding could be eliminated and turtle disease vastly reduced by isolating each hatchling in individual containers within the raceways. Therefore, in subsequent rearing practices, individual turtles were isolated in perforated buckets suspended in the raceways. Survival rate for the 1978 year-class was 68 percent.

Bowel compaction was common among the hatchlings of the 1977 and 1978 year-classes. In attempts to develop a diagnostic tool for this condition, a cooperative effort was launched (with Dr. G. L. McLellan) to explore the use of x-ray technology. Tests showed that the barium-fluoroscopic method, normally used on humans with gastrointestinal problems, produced good quality x-ray films of the gastrointestinal tracts of healthy hatchlings (McLellan and Leong 1981). This result indicated that x-radiography was potentially useful for diagnosing intestinal obstructions in sea turtle hatchlings.

Kidney infection was another malady requiring internal diagnosis. We tried, unsuccessfully, to develop radiological diagnostic techniques, using radio-opaque material. We learned from this trial, however, that subcutaneous injections of a radio-opaque material, sodium diatrizoate, administered to the neck region, were absorbed much faster than those administered to the suprafemoral pouch (referred to as "hind limb" in McLellan and Leong 1982), as was the general practice in parenteral administration of drugs for disease treatment in turtle hatchlings. This finding suggested that injection of drugs into the neck area for disease treatment was probably more effective than injection into the suprafemoral pouch (McLellan and Leong 1982).

In 1979 and 1980, prevention and treatment of diseases in ridleys contributed to survival rates of 83 and 95%, respectively. During this time, however, an outbreak of a bloating syndrome affected more than 300 ridley hatchlings, killing about 150 of them. Autopsies revealed that the animals had duodenal ulcerations. Follow-up clinical observations and feeding experiments showed that a modification of feeding regimens, either by reducing the amount and frequency of feeding from 4 times to 2 times per day or less, or by replacing the manufactured turtle feed with a ground fish diet, were successful in stopping the spread of the bloating, and led to the recovery of the sick turtles.

The 1,865 ridley hatchlings received in 1981 did not fare nearly as well as the 1980 year class. From the outset, the 1981 year-class was plagued with at least two kinds of fungal infections. The first type surfaced in August 1981 shortly after the hatchlings arrived at the Galveston Laboratory. Autopsies revealed a hardened yolk sac, heavily infested with fungal spores and mycelia. Three different fungi were isolated in laboratory cultures. One, *Paecilomyces* sp., was suspected to be a pathogen. More studies will be needed to confirm the pathogenicity of the isolated fungi. In slightly older hatchlings, a similar type of fungal infection, also apparently associated with *Paecilomyces*, was found in the liver, lung, muscle, and brain. To date, there has been no effective treatment for the *Paecilomyces* type infection, but circumstantial evidence suggested that sunlight could be helpful in curing head lesions infected by the fungus. Generally, infected hatchlings show few external signs or symptoms that can be used for early diagnosis, although in advanced stages of the disease, sick turtles are emaciated and stunted in growth.

Another type of mycotic infection in the 1981 year-class involved the fungus *Scolecobasidium constrictum*. The primary site of infection was in lung tissue, but the fungus was also observed to damage bone tissue. The disease usually did not become apparent until the affected turtles were 6 to 7 months old. So far, we have not found a cure. By providing the sick animals with a clean and warm environment during clinical isolation, however, we have been able to obtain spontaneous recovery in some cases. In June 1982, the survival rate of the 1981 year-class prior to release was 79%.

We have not determined whether the diseases occurring in captive sea turtles also occur in the wild, or if they are peculiar to the conditions of rearing sea turtles at the Galveston Laboratory. Nevertheless, it is clear that successful disease prevention and treatment have contributed greatly to the high survival rates experienced with these animals in captivity during their first year of life. Such success has led to the release of larger numbers of healthy, yearling Kemp's ridley sea turtles, which we hope will contribute significantly in the years ahead toward the conservation of the species. The Galveston Laboratory has continued with sea turtle pathology research to try to improve techniques and methods for diagnosis, prevention, and treatment for diseases and injuries in sea turtles.

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THE ESTABLISHMENT OF *Podarcis muralis* IN CINCINNATI, OHIO

Several species of European animals have been purposely and accidentally released in the United States. Among the earliest planned introductions were those that occurred during the years 1872-1874, when 4000 individuals of 20 European birds were imported to Ohio for release in Cincinnati (Langdon 1881). This attempt by the Acclimatization Society of Cincinnati to increase the number of Ohio songbirds ended in total failure. Not even the European starling, *Sturnus vulgaris*, survived, although the species later spread through most of the United States following its successful 1890 and 1891 introductions in New York City (Long 1981).

Exact dates of accidental introductions are more difficult to determine. For example, the European lizard colonies *(Podarcis sicula* and *Lacerta viridis)* in Topeka, Kansas, were probably established in the 1950s from specimens that escaped from an animal dealer (Collins 1982). Conant (1945) reported the occasional appearance of various European lizards on the piers and grounds of a cork import company in Gloucester, New Jersey. While none of the four observed species succeeded in establishing themselves in Gloucester, one of them, *Podarcis muralis*, did succeed when it was deliberately introduced in Cincinnati.

In September 1951, following a family visit to Europe, a Cincinnati resident brought two European wall lizards, *P. muralis*, to the United States. The animals had been caught in the Lake Como area of northern Italy, and were released in the backyard of the resident's Cincinnati home. The *P. muralis* population has since spread throughout much of southeastern Cincinnati. The purpose of this note is to outline the possible reasons for the success of this European wall lizard transplantation.

Hundreds of European plant and animal species have been established in North America, but relatively few have invaded native habitats. The vast majority occupy cultivated and urban areas, new habitats that humans introduced to North America (Elton 1958; MacArthur 1972). Indigenous American species did not have time to colonize these manmade habitats before the arrival of such immigrants as chicory, *Cichorium intybus*, dandelion, *Taraxacum officinale*, cabbage butterfly, *Artogeia rapae*, Norway rat, *Rattus norvegicus*, and starling, *S. vulgaris*. These species succeeded in their new American environments because they were already adapted to living alongside humans in towns and fields of Europe.

The wall lizard, *P. muralis*, is a good example of an animal that lives in association with human habitations in Europe. It seems likely that *P. muralis* evolved in dry, rocky regions and that it spread into many of the areas it now occupies subsequent to human agricultural and construction activities. In Europe, I have observed wall lizards on stone walls, sides of houses, piles of rocks, and railway embankments. According to Arnold and Burton (1978), *P. muralis* is the most urban Lacertid in Europe.

The two wall lizards transplanted to Cincinnati in 1951 (not 1948 as reported by Vigle 1977) were released on a stone wall. Their descendents have since spread to limestone rock outcrops and all of the same urban habitats as those listed above in Europe. The wall lizard's ability to adapt to the Cincinnati environment is largely due to pre-adaptation in its original range.

In addition to suitable habitat, lack of competition is another obvious criterion for the success of imported species. *P. muralis* has not had to compete with native lizards in its present 6 km^2 Cincinnati range. The eastern fence lizard, *Sceloporus undulatus*, five-lined skink, *Eumeces fasciatus*, and broad-headed skink, *E. laticeps*, occur in the Cincinnati region (Conant 1951), but none of these species inhabit the area that has been colonized by *P. muralis* since 1951.

Another European species, the starling, *S. vulgaris*, is also found throughout the area now occupied by *P. muralis*. Like the wall lizard, the immigrant starling is pre-adapted to an urban habitat and meets with little competition from native animals (Forbush 1920). But unlike the wall lizard introduction, the deliberate transplantation of foreign-born starlings to Cincinnati was unsuccessful, possibly due to climatic differences between the starlings' native localities and Cincinnati (Roots 1976).

Unlike the initially unsuccessful starlings, the wall lizards from Italy's Lake Como region were probably better pre-adapted to Cincinnati's climate. Similar temperature and precipitation patterns occur in Cincinnati and Milan, the meteorological station nearest Lake Como, 40 km distant (Fig. 1). The average monthly temperature is 13.3 ° C in Cincinnati and 12.8 ° C in Milan. The average monthly precipitation is 82 mm in Cincinnati

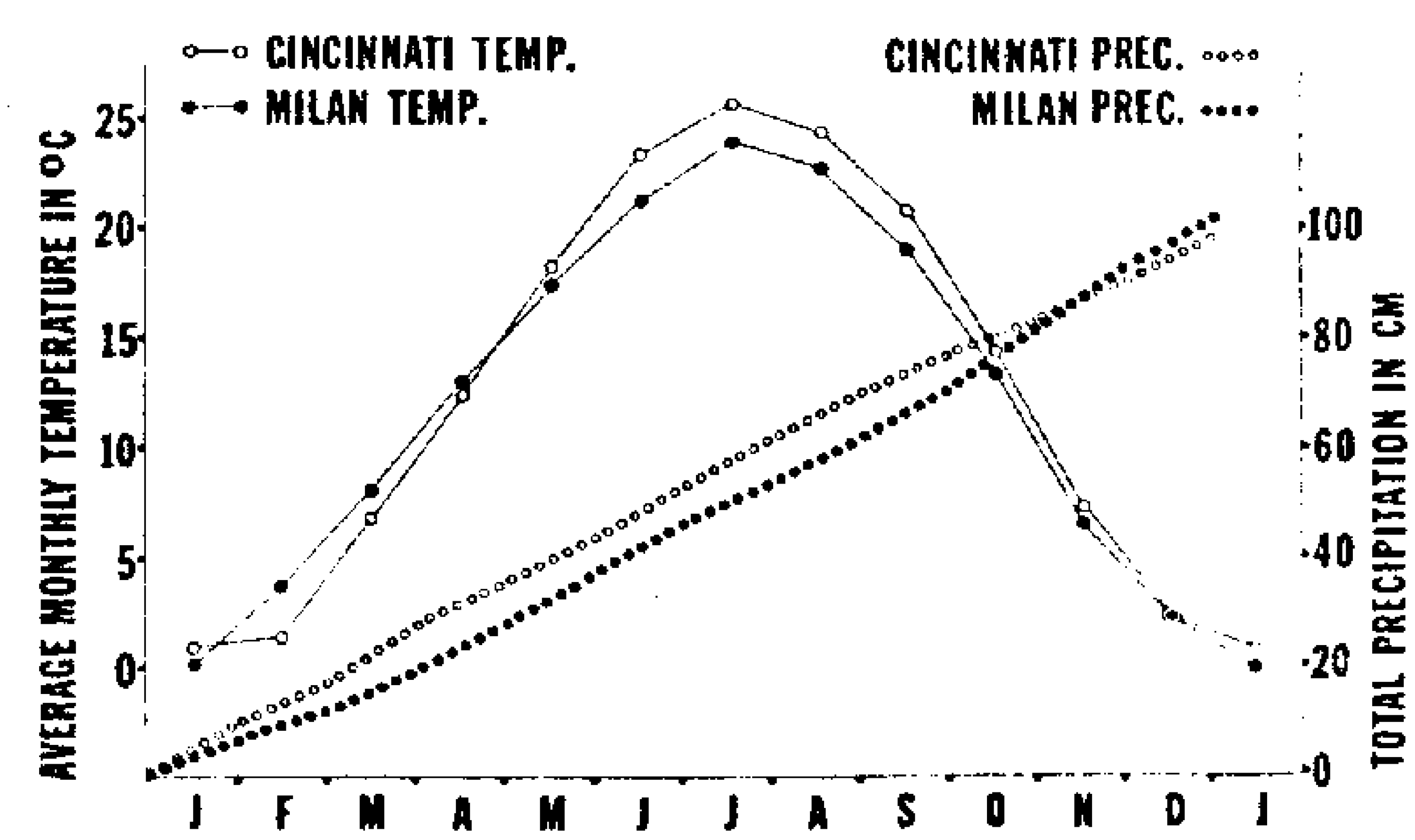

Figure 1. Temperature and moisture patterns of Cincinnati, Ohio and Milan, Italy (data from Miller 1961).